Superfund Program
U.S. Environmental Protection Agency
Region 2
Proposed Plan

Welsbach/General Gas Mantle Superfund Site
Operable Unit (OU) 4
Camden and Gloucester City, New Jersey

August 2021

EPA ANNOUNCES PROPOSED PLAN

This Proposed Plan describes the remedial alternatives that the United States Environmental Protection Agency (EPA) has considered to remediate contaminated groundwater at the Welsbach/General Gas Mantle (GGM) Superfund Site (Site), located in Camden and Gloucester City, Camden County, New Jersey, and identifies EPA's preferred interim remedy, along with the reasons for this preference.

The Site cleanup is being addressed in four phases or operable units (OUs), which are described below in the "Scope and Role of the Action" section. This plan for OU4 of the Site proposes an interim action to address groundwater impacted by Site contamination.

The preferred alternative, Alternative 2, described in this Proposed Plan for OU4 includes radioactive decay with institutional controls (ICs) and Long-Term Monitoring (LTM) for groundwater.

This Proposed Plan was developed by EPA, the lead agency for the Site, in consultation with the New Jersey Department of Environmental Protection (NJDEP), the support agency. EPA is issuing this Proposed Plan as part of its public participation responsibilities under Section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA or Superfund). EPA will select an interim remedy for contaminated groundwater at OU4 after reviewing and considering all information submitted during the 30-day public comment period.

MARK YOUR CALENDAR

Public Comment Period – August 24 to September 24, 2021
EPA will accept written comments on the Proposed Plan during the public comment period.

Virtual Public Meeting
EPA will hold a **Virtual Public Meeting** on September 8, 2021 from 6:00-8:00 PM to explain the Proposed Plan and the alternatives presented in the Feasibility Study. To register for the public meeting, visit https://welsbach-ggm.eventbrite.com.

To learn more about the public meeting, visit https://www.epa.gov/superfund/welsbach-ggm or contact Natalie Loney, Community Involvement Coordinator at loney.natalie@epa.gov or (212)-637-3639.

Anyone interested in receiving materials for the public meeting in hard copy should either email or call Ms. Loney with such a request by Thursday September 2, 2021.

The Administrative Record file containing the documents used in developing the alternatives and preferred cleanup plan is available for public review at EPA's website for the Welsbach/GGM Site:

https://www.epa.gov/superfund/welsbach-ggm

Community Role in the Selection Process

This Proposed Plan is being issued to inform the public of EPA's preferred alternative and to solicit public comments pertaining to the remedial alternatives evaluated, including the preferred alternative. EPA relies on public input to ensure that the concerns of the community are considered in selecting an effective remedy for each Superfund site.

This Proposed Plan is available to the public for a public comment period that concludes on September 24, 2021.

A public meeting will be held by EPA during the public comment period to present the conclusions of the Remedial Investigation/Feasibility Study (RI/FS), elaborate further on the basis for identifying the preferred alternative, and receive public comments. The public meeting will include a presentation by EPA of the preferred alternative and the other evaluated alternatives. Information on the public meeting and submitting written comments can be found in the "Mark Your Calendar" text box on page 1.

Comments received at the public meeting, as well as written comments, will be documented in the Responsiveness Summary Section of the Record of Decision (ROD), the document that formalizes the selection of the interim remedy.

EPA may modify the preferred alternative or select another response action presented in this Proposed Plan based on new information or public comments. Therefore, the public is encouraged to review and comment on all the alternatives presented in this Proposed Plan. This Proposed Plan summarizes information that can be found in greater detail in the final RI Report and final FS Report and other documents contained in the Administrative Record for the proposed OU4 interim remedy for this Site.

Scope and Role of the Action

The Welsbach/GGM Site is being addressed as four operable units (i.e., discrete phases of work). OU4, which is the subject of this Proposed Plan, consists of radiological impacts to the groundwater from soil contamination related to the Site.

A ROD for Operable Unit 1 (OU1) was issued by EPA in 1999 which addressed radiologically contaminated soils and waste material at the former Welsbach and GGM facilities, and other properties in Camden and Gloucester City. The OU1 remedial action is in progress. A ROD for OU2 was issued by EPA in 2011 which addressed the radiological contamination in the Armstrong Building, the last remaining building from the gas mantle manufacturing operations of the Welsbach Company (Welsbach) located at the former Welsbach facility (FWF). The remedial action for OU2 was completed in 2017.

A ROD for OU3 was issued by EPA in 2005 which evaluated the potential radiological contamination in the surface water, sediment, and wetland areas around the Site. EPA determined that no action was necessary for OU3.

This Proposed Plan summarizes the proposed interim action to address OU4 of the Site, which is groundwater impacted by Site contamination.

EPA uses interim actions to address areas or contaminated media that ultimately may be included in the final ROD for a site. Interim actions include measures to treat contamination in an operable unit, prevent migration of contaminants or further environmental degradation or minimize human exposure until such time as a final remedial decision is issued.

This proposed interim remedy will ensure measures are in place to prevent potential exposure to radiological contaminants in groundwater through the use of institutional controls (establishing a Classification Exception Area {CEA}/Well Restriction Area {WRA}) while the on-going OU1 remedial action progresses. Long-term groundwater monitoring will assess the progress of the implemented interim action. In conjunction with the on-going radiologically contaminated soil excavation and off-site disposal remedial action, groundwater and soil data will be collected to determine a permanent remedy for groundwater.

SITE BACKGROUND

Site Description

The Site is located within the cities of Camden and Gloucester City in Camden County, New Jersey, adjacent to the Delaware River and directly east of Philadelphia, Pennsylvania. The Site includes residential, commercial, industrial, and recreational properties.

OU4 comprises groundwater underlying the following six property groupings (Figure 1). The groupings were selected because these properties had the most significant Site-related soil contamination (i.e., largest extent of contamination and highest concentrations of contaminants), which is the source of potential groundwater contamination. The remedial actions subsequently described for each property grouping either have been completed or are currently being performed as part of the OU1 ROD. The description of the property groupings, as well as the estimated volume of radiologically contaminated soil previously excavated and disposed off-site, are as follows:

GGM – This is the northernmost property grouping and is located near the Delaware River. This grouping contains the former GGM facility, several commercial properties, railroad tracks, roadways, and numerous former residential properties that have been abandoned and demolished. Removal and off-site disposal of approximately 30,000 cubic yards (CY) of radiologically contaminated soil was completed in this area in 2012.

Swim Club – This property grouping is located along Newton Creek, north of the Johnson Boulevard Grouping. This grouping contains a recreational facility consisting of several swimming pools and tennis courts, several streets, railroad tracks, and several residential properties. Due to the depth of contamination, eleven residential properties were demolished during remedial activities to facilitate excavation; five were replaced with modular homes while the residents in the other six houses were permanently relocated. Removal and off-site disposal of approximately 77,000 CY of radiologically contaminated soil was completed in 2006.

Johnson Boulevard – This property grouping is located adjacent to, and south of, the Swim Club grouping, along Newton Creek. This grouping consists of recreational facilities including numerous ball fields and a jogging track, several railroads, and an undeveloped area containing wetlands. Removal and off-site disposal of approximately 90,000 CY of radiologically contaminated soil was completed in 2013.

Temple Avenue – The Temple Avenue property grouping is located near the southeast boundary of the Johnson Boulevard property grouping, along Newton Creek. This grouping contains a residential property, wetlands, and two roadways. Removal and off-site disposal of approximately 20,000 CY of radiologically contaminated soil was completed in 2009.

Hunter Street – This property grouping is located south of the FWF. This grouping consists of residential properties and several roadways. Removal and off-site disposal of approximately 1,300 CY of radiologically impacted soil was completed in 2014.

FWF – This is the largest property grouping and is located along both the Delaware River and Newton Creek. This property grouping is currently an active port facility and the FWF, which covered approximately 27 acres, operated in the center of the property. Excavation of radiologically contaminated soil has resulted in the removal and off-site disposal of approximately 10,400 CY of radiologically contaminated soil to date. The vast majority of radiologically contaminated soil yet to be addressed remains on this property grouping. It is estimated that over 200,000 CY of radiologically contaminated soil remains to be excavated at the FWF. EPA currently estimates that soil excavation/off-site disposal efforts will be completed in ten years.

Site History

Between the 1890s and 1940s, Welsbach manufactured gas mantles at its facility in Gloucester City, New Jersey. Beginning around 1895, Welsbach imported monazite ore to use as its source of the radioactive element thorium. Welsbach extracted thorium from the ore and used it in its gas mantle manufacturing process since thorium caused the mantles to glow brightly when heated. Just after the turn of the 20th century, Welsbach was the largest producer of gas mantles and lamps in the United States, making up to 250,000 mantles per day. Welsbach went out of business in 1940.

A second gas mantle manufacturing company, GGM, located in Camden, New Jersey, was a small competitor to Welsbach. GGM operated from 1912 to 1941. While there is little information on GGM's activities, it appears that GGM only used refined thorium in its gas mantle manufacturing processes.

During the years Welsbach was in operation, the residual material from processed monazite ore, which still contained radioactive elements, as well as other elements, was used as fill throughout Gloucester City. The fill was also used in the construction of residential and commercial buildings and in low-lying areas in and around the Welsbach facility. Over the past 100 years, a number of Welsbach buildings were demolished, and the building debris may also have been used as fill in the Gloucester City area.

The Site was initially identified by EPA as part of its investigation at the U.S. Radium Corporation Superfund Site in Orange, New Jersey. Records from U.S. Radium indicated it purchased radium from Welsbach. In 1981, as a result of this information, EPA sponsored an aerial radiological survey of the Camden and Gloucester City area to investigate the possible presence of radioactive contamination. Based on an evaluation of these data, EPA identified six study areas for the Site.

In 1996, EPA placed the Site on the National Priorities List (NPL), and in 1997, EPA began to perform a RI/FS for OU1 of the Site. The RI/FS Reports were finalized in January 1999. In July 1999, EPA issued a ROD for OU1. The selected remedy for OU1 included excavation and off-site disposal of radiologically contaminated soil and waste materials from the former Welsbach and GGM facilities and the nearby residential and commercial properties. The remedy also included decontamination and demolition of the GGM building.

In 2011, EPA issued the ROD for OU2. The selected remedy presented in the ROD included decontamination of radiologically contaminated building surfaces and off-site disposal of radiologically contaminated waste materials from the Armstrong Building, the last remaining building from Welsbach's gas mantle operations located at the FWF. Remediation of the Armstrong Building was completed in 2017.

In 2002, EPA conducted investigations and developed human health and ecological risk assessments for OU3, which consists of the surface water, sediments and wetland areas along the South Branch of Newton Creek, Martin's Lake, and the Delaware River, in the vicinity of the Site to evaluate impacts to these areas from Site contamination. In July 2005, EPA issued a ROD for OU3, which indicated that no remedial action was necessary for surface water, sediments, and wetland areas along the South Branch of Newton Creek, Martin's Lake, and the Delaware River.

This Proposed Plan for OU4 identifies EPA's preferred alternative for an interim remedy to address Site related impacts to groundwater.

Geology and Hydrology

The OU4 property groupings are in the Camden and Gloucester City region of New Jersey, which is on the western edge of the Atlantic Coastal Plain. This area is underlain by the Potomac-Raritan-Magothy (PRM) aquifer system. The PRM aquifer is considered, under the State of New Jersey's groundwater classification system, a Class II-A aquifer (i.e., water that is potable or potentially potable). In the area of the OU4 property groupings, the PRM aquifer system is approximately 150 to 300 feet thick.

Beneath the OU4 property groupings, surficial geology consists of artificial fill, alluvium, and salt marsh and estuarine deposits, which in turn overlies the PRM and the crystalline bedrock beneath the PRM. The majority of fill is associated with highway and railroad embankments and was placed in marshes and floodplains.

The PRM aquifer system includes three aquifers designated Lower, Middle, and Upper based on their position within the system. In the area of the Site, the depth of the Upper aquifer is from approximately 10 to 115 feet below ground surface (bgs). The depth of the Middle aquifer is from approximately 135 to 185 feet bgs, and the depth of the Lower aquifer is from approximately 215 to 300 feet bgs. Current groundwater flow in the Upper PRM aquifer is generally to the east/southeast, away from the Delaware River. Groundwater is induced to flow away from the Delaware River by the extensive regional pumping of groundwater from the PRM for both public supply and commercial uses.

The groundwater elevation near OU4 is about 7 feet below sea level (near the Delaware River) and declines to the east with increasing distance from the river. Depth to groundwater within the six property groupings ranges from approximately 2 to 17 feet bgs. The slope of water surface of the groundwater table (i.e., hydraulic gradient) ranges from 0.0002 to 0.013 feet per foot within the property groupings, which is considered relatively flat. Within the property groupings the range of velocity for groundwater movement is 0.01 to 0.55 feet per day, which is considered relatively slow. The impact of tidal variability had little effect on the aquifer water levels. Tidal changes of more than 5 feet in the Delaware River correlated to aquifer water level changes of no more than 0.2 feet.

NATURE AND EXTENT OF CONTAMINATION

The source of groundwater contamination from radionuclides at the Site is from residual material from processing monazite sands, a raw material used in the gas mantle manufacturing process. Generally, gas mantle manufacturing at the Site involved extracting the radioactive element thorium from imported monazite sands which yielded radioactive residual material. This material, which still contained radioactive elements, including radium (Ra), and other elements, was used as fill throughout Gloucester City for the construction of residential and commercial buildings and in low-lying areas in and around the Welsbach facility and Gloucester City. Radium is an element that is formed by the radioactive decay of Th and exists as two different isotopes, Ra-226 and Ra-228.

As part of the RI, groundwater samples were collected from both public potable supply wells and monitoring wells located within the six property groupings comprising OU4. Analytical results were compared to the federal and New Jersey maximum contaminant levels (MCLs) as well as New Jersey Groundwater Quality Standards (GWQS).

Groundwater samples were collected from three potable public supply wells owned and operated by Gloucester City; Wells 41, 42, and 43, prior to treatment and distribution. The public supply wells range in depth from 267 feet to 306 feet below ground surface (bgs). Exceedances above the MCL or GWQS were observed in these wells for some chemical constituents (i.e., iron, manganese and 1,4 dioxane). These exceedances are not related to past activities at the Site. None of the samples exceeded the MCL or GWQS for the radiological constituents of concern, including Ra-228. Drinking water supplied by Gloucester City is treated at the Johnson Boulevard Water Treatment Plant and meets all federal and state drinking water standards after treatment.

Historic fill exists throughout Gloucester City and Camden and is present on all the property groupings. NJDEP defines historic fill as material generally deposited to raise the topographic elevation of an area, which was contaminated prior to emplacement. To evaluate groundwater quality at the Site with the presence of extensive historic fill, both background (i.e., upgradient and cross-gradient) and downgradient (i.e., on-site and downgradient) monitoring wells were installed during the RI at all property groupings except the FWF. Because the majority of the soil remediation at the FWF has not been completed yet, and groundwater flow at the FWF runs perpendicular to the Delaware River, a viable location for an upgradient background well does not exist. Therefore, upgradient background wells could not be installed at the FWF.

The RI included the installation of thirty-nine (39) permanent monitoring wells and six (6) temporary monitoring wells. Permanent monitoring wells were installed in the shallow and deep portions of the Upper aquifer of the PRM. Shallow wells were installed to approximately 20-30 feet bgs. Deep wells were installed to approximately 65-70 feet bgs. Temporary monitoring wells were advanced at the FWF to the top of the confining unit between the Upper and Middle aquifers of the PRM, an approximate depth of 90-100 feet bgs.

Two rounds of groundwater samples were collected from the permanent monitoring wells and one round of groundwater samples was collected from the temporary wells as part of the RI. During the first sampling round conducted from November to December 2018, the 39 monitoring wells, as well as public supply wells from Gloucester City, were sampled. During the second groundwater sampling round, conducted in May 2019, only the monitoring well network installed for the RI was sampled. The temporary monitoring wells were installed between 2018 and 2020 to horizontally and vertically delineate Ra-228 (the only radionuclide detected at concentrations that exceeded the MCLs and GWQS) impacts in groundwater identified previously at the FWF.

Contaminants of potential concern (COPCs) were detected in many of the monitoring wells, both in background and downgradient wells, at concentrations that exceed both the MCLs and GWQS. While the constituents exceeded screening criteria, they were either not related to Site activities or are associated with historic fill, and represent an area-wide historic fill impact (i.e., present within each of the property groupings).

None of the groundwater samples collected from five of the six property groupings (GGM, the Swim Club, Johnson Boulevard, Temple Avenue, and Hunter Street) had Site-related radiological contaminants that exceeded the MCLs or GWQS.

However, Ra-228 was a Site-related radiological contaminant detected at the sixth property grouping (FWF) at concentrations up to 28.8 picocuries/liter (pCi/L) in monitoring well SGMW-3D, which exceeded the MCL. The MCL (both State and Federal) and GWQS for total Radium (Ra-226 and Ra-228) is 5 pCi/L.

Temporary monitoring wells were installed between 2018 and 2020 to determine the horizontal and vertical extent of the Ra-228 contamination in groundwater at the FWF. Ra-228 was detected at concentrations above the MCL (5 pCi/L) at depths ranging from approximately 18 to 65 feet bgs. The depth to groundwater is approximately 16 feet bgs.

The horizontal area of groundwater contamination is approximately 200 feet long by 100 feet wide. Although data collected during the RI indicated the downgradient extent of Ra-228 was sufficiently delineated for the purposes of selecting an interim remedy, the full extent of groundwater contamination in the eastern direction will be further defined during the design phase of the remedy.

The groundwater contamination resulted from the presence of the residual waste materials from monazite ore processing in the soil. The processed ore was placed on-Site as fill material and the fill material/soil impacted shallow groundwater. The depth of the fill material ranges from approximately 1 to 20 feet bgs. Direct contact of radium and thorium with soil generally causes these elements to bind to the soil particles based on their physical properties. They do not tend to readily migrate in groundwater under neutral pH conditions (a measure of an acidic or basic environment).

Past business operations at the FWF circa 1890-1940 included discharge of acidic wastes south of the Armstrong Building. This waste was discharged to the ground surface resulting in an acidic soil environment. The acidic soil environment caused the Ra-228 to leach from the deposited fill material and travel deeper into the soil matrix and groundwater (approximately 60-65 ft bgs). Once the acid discharge ceased due to the discontinuation of manufacturing operations, neutral pH conditions returned to soil and groundwater. Therefore, it is expected that the current environment is significantly less favorable to migration of Ra-228 from soil to groundwater.

The limited ability of Ra-228 to migrate from soil to groundwater and within the groundwater is further supported by several additional factors that have been observed during the RI and in the implementation of the remedies for the other OUs. Field data collected during the RI showed that pH in soil is currently within a neutral range (approximately 6.5 – 8.5). As presented in the RI, there is a significant decrease in Ra-228 concentrations between the maximum concentration detected in groundwater at TWP-SG3C (98.3 pCi/L) and TWP-SG3F (7.1 pCi/L). TWP-SG3F is located approximately 160 feet east of TWP-SG3C (see Figure 2). The velocity of groundwater movement is very slow and further limits the downgradient migration of Ra-228.

Additionally, the soil contamination has been present at the FWF for approximately 100 years and the associated groundwater contamination has remained localized, suggesting significant migration from the source area is not expected. Finally, no radiological contaminants were observed in groundwater in areas where soil remediation has been completed indicating that radiological contaminants do not readily migrate from soil to groundwater.

The results of laboratory analyses of the groundwater samples collected are presented in the RI Report dated June 2021, which is part of the administrative record file for OU4 of the Site.

RISK SUMMARY

As part of the OU4 RI/FS, a baseline risk assessment was conducted by EPA to estimate the current and future effects of contaminants on human health and the environment. A baseline risk assessment is an analysis of the potential adverse human health and ecological effects of releases of hazardous substances from a site if no actions to mitigate such releases are taken, under current and potential future soil, groundwater, surface water and sediment uses. The baseline risk assessment included a human health risk assessment (HHRA).

An ecological risk assessment was not conducted as part of OU4 since ecological concerns at the Site were assessed as part of the 2005 ROD for OU3. The results of the screening level ecological risk assessment conducted as part of OU3 concluded that the radiological concentrations in sediment and surface water were well below the Department of Energy guidelines. Concentrations of radiological contaminants from sediment samples collected were indistinguishable from background radiation levels found in the area. Therefore, EPA concluded that radiological contaminants associated with the Site did not warrant an action based on ecological risk.

Human Health Risk Assessment Process

EPA conducts a four-step HHRA to assess site-related cancer risks and noncancer health hazards in the absence of any remedial action. The four-step process is comprised of: Hazard Identification, Exposure Assessment, Toxicity Assessment and Risk Characterization (refer to the text box "What is Human Health Risk and How is it Calculated").

The HHRA began with selecting COPCs in the affected media (*i.e.*, groundwater) that could potentially cause adverse effects in potentially exposed populations. COPCs are selected by comparing the maximum detected concentrations of each chemical identified with State and federal risk-based screening values.

Both Site-related contaminants that were identified as COPCs in groundwater and non-Site-related COPCs were selected for evaluation in the HHRA. The Site-related COPCs are aluminum, beryllium, lead, manganese, nickel, total uranium and all radionuclides in the uranium series, thorium series, and actinium series.

Radionuclides and their decay products, specifically radium (as Ra-228), are considered the primary COPCs in groundwater. This is based on historical information collected about the gas mantle manufacturing process as well as soil and groundwater data collected during the RI.

The exposure assessment identified potential human receptors based on a review of current and reasonably anticipated future land use at the Site. The Site currently includes residential, commercial, and industrial properties as well as a port facility. These land uses are also the currently anticipated future land uses for the Site.

Note that the current and future receptor populations include commercial/industrial (adult) which would be workers in a business or manufacturing setting that could be potentially exposed as well as a construction/utility worker (adult) which would include building or utility (e.g., electrical/gas/water line) construction workers that could be exposed to groundwater contaminants.

Based on the current and reasonably foreseeable future land uses of the Site, the following receptor populations and exposure pathways were identified and evaluated in the HHRA:

- Commercial/industrial workers (adult): via sanitary use of potable water, including tap water ingestion, dermal contact through hand washing and inhalation of volatile chemicals or radon through releases to indoor air, as well as use in an industrial process (i.e., water that is used in a manufacturing process) through ingestion and dermal contact during a standard

8-hour workday, and inhalation of volatile chemicals or radon gas released to indoor air.

- Construction/utility workers (adult): via dermal contact with groundwater and inhalation of volatile chemicals or radon released from the surface of pooled groundwater at the bottom of an excavated trench to ambient air.

- Residents (adult/child): although OU4 groundwater is not currently used for drinking water, the potential for potable use of the groundwater, as well as the potential for dermal contact and inhalation exposure to COPCs in groundwater used for sanitary purposes (e.g., hand washing), was evaluated as a potential future use.

To determine the contaminant concentrations in groundwater and air to which an individual might be exposed over many years, representative exposure point concentrations (EPC) were calculated from the available groundwater data. EPCs used in the calculation of cancer and noncancer hazards were estimated for each COPC (including both Site-related and non-Site related COPCs).

Inhalation of volatile COPCs and radon gas potentially released to indoor air during household, sanitary, and industrial or process use of the groundwater, was evaluated using concentrations calculated using the Andelman Volatilization Factor (VF) for volatile COPCs and radon gas in indoor air.

Construction/utility worker inhalation exposures were based on concentrations of volatile COPCs and radon gas in outdoor air of an excavation using the Andelman VF.

Vapor intrusion pathway EPCs for volatile COPCs in indoor air were estimated using the EPA's version of the Johnson and Ettinger model (Johnson and Ettinger 1991).

In the risk assessment, two types of toxic health effects were evaluated for COPCs: cancer risk and noncancer hazard. Calculated cancer risk estimates for each receptor were compared to EPA's target risk range of $1x10^{-6}$ (one-in-one million) to $1x10^{-4}$ (one-in-ten thousand). The calculated noncancer

WHAT IS *HUMAN HEALTH* RISK AND HOW IS IT CALCULATED?

A Superfund baseline human health risk assessment is an analysis of the potential adverse health effects caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these under current and future land uses. A four-step process is utilized to assess site-related human health risks for reasonable maximum exposure scenarios.

Hazard Identification: In this step, the contaminant of potential concern (COPCs) at a site in various media (*e.g.,* soil, surface water, and sediment) are identified based on such factors as toxicity, frequency of occurrence, fate and transport of the contaminants in the environment, concentrations of the contaminants in specific media, mobility, persistence, and potential for bioaccumulation.

Exposure Assessment: In this step, the different exposure pathways through which people might be exposed to the contaminants identified in the previous step are evaluated. Examples of exposure pathways include incidental ingestion of contaminated soil. Factors relating to the exposure assessment include, but are not limited to, the concentrations that people might be exposed to and the potential frequency and duration of exposure. Using these factors, a reasonable maximum exposure scenario (RME), which portrays the highest level of human exposure that could reasonably be expected to occur, is calculated.

***Toxicity Assessment**:* In this step, the types of adverse health effects associated with chemical exposures and the relationship between magnitude of exposure and severity of adverse effects are determined. Potential health effects are chemical-specific and may include the risk of developing cancer over a lifetime or other non-cancer health effects, such as changes in the normal functions of organs within the body (*e.g.*, changes in the effectiveness of the immune system). Some chemicals can cause both cancer and non-cancer health effects.

Risk Characterization: This step summarizes and combines outputs of the exposure and toxicity assessments to provide a quantitative assessment of site risks. Exposures are evaluated based on the potential risk of developing cancer and the potential for non-cancer health hazards. The likelihood of an individual developing cancer is expressed as a probability. For example, a 10^{-4} cancer risk means a one-in-ten-thousand excess cancer risk; or one additional cancer may be seen in a population of 10,000 resulting from exposure to site contaminants under the conditions explained in the Exposure Assessment. Current guidelines for acceptable exposures are an individual lifetime excess cancer risk of 10^{-4} to 10^{-6} (corresponding to a one in ten thousand to a one in a million excess cancer risk) with 10^{-6} being the point of departure. For non-cancer health effects, a HI is calculated. An HI represents the sum of the individual non-carcinogenic exposure levels compared to their corresponding reference doses. The key concept for a non-cancer HI is that a threshold level (measured as an HI of 1) exists below which non-cancer health effects are not expected to occur. The goal of protection is 10^{-6} for cancer risk and an HI of 1 for a noncancer health hazard.

hazard index (HI) estimates were compared to EPA's target threshold value of 1.

Groundwater Cancer Risks

Cancer risks and noncancer hazards were evaluated for exposure to OU4 groundwater. Although OU4 groundwater is not currently used for drinking water, a hypothetical future commercial/industrial and residential potable use and sanitary use scenario were evaluated for these two populations.

As shown in Table 1, baseline cumulative excess lifetime cancer risks (ELCRs) estimated under the RME scenarios (i.e., the highest level of human exposure that could reasonably be expected to occur) ranged from 3×10^{-6} for construction/utility worker exposure to shallow groundwater in the Johnson Boulevard-Temple Avenue property grouping, to 1×10^{-2} for the combined resident adult/child exposed to the entire aquifer (i.e., shallow and deep aquifer groundwater) in the Swim Club and GGM property groupings.

Under the RME scenario, the baseline cumulative ELCRs for the combined resident adult/child (hypothetical future potable use scenario) and the commercial/industrial worker (hypothetical future potable and process use scenario) in all five property groupings were greater than the cancer risk range of 1×10^{-4} to 1×10^{-6} established by the National Contingency Plan (NCP). The potential for ELCR was largely attributable to concentrations of Ra-228 at the FWF and arsenic and radon at all the property groupings.

For the commercial/industrial worker (hypothetical future potable and sanitary use scenario), RME ELCRs greater than 1×10^{-4} were estimated for the FWF, Hunter Street and Johnson Boulevard-Temple Avenue property groupings, while RME ELCRs for the Swim Club and GGM property groupings were equal to 1×10^{-4}.

For the current/future construction/utility worker, RME ELCRs were within the risk range of 1×10^{-6} to 1×10^{-4} established by the NCP for all three shallow groundwater property groupings evaluated. Construction/utility worker exposure to groundwater deeper than 10 feet bgs is not expected. Therefore, construction/utility worker exposure to deep aquifer groundwater was not evaluated.

The detections of Ra-228 at the FWF was the COPC that indicated a potential source area associated with the Site. The ELCR attributable to Ra-228 was 3×10^{3} due to a hypothetical future potable water use exposure scenario.

Groundwater Noncancer Hazards

Baseline cumulative noncancer HIs estimated under the RME scenarios ranged from 0.08 for current/future construction/utility worker exposure to shallow groundwater in the Johnson Boulevard-Temple Avenue property grouping, to 47 for the combined resident adult/child (hypothetical future potable use scenario) exposed to the entire aquifer (i.e., shallow and deep groundwater).

Under the RME scenario, the baseline cumulative noncancer HIs were greater than 1 for the combined resident adult/child (hypothetical future potable use scenario), the commercial/industrial worker (hypothetical future potable and sanitary use scenario), and the commercial/industrial worker (hypothetical future potable and process use scenario) in all five property groupings evaluated, indicating there is a potential for adverse, noncancer health effects from exposure to groundwater. Depending on the property grouping evaluated, the potential for unacceptable hazard (i.e., Hazard Quotient {HQs} greater than 1) is attributable to arsenic, cobalt, cyanide, iron, manganese, and/or thallium.

For the construction/utility worker, noncancer HIs were less than 1 indicating adverse health effects are unlikely for the three property groupings that contained shallow groundwater at depths ranging from 5 to 10 feet. At these depths to groundwater, current or future construction/utility workers could be exposed to constituents in shallow groundwater that infiltrates an excavation for construction or utility work.

Air Cancer Risks and Noncancer Hazards

The RME ELCRs and noncancer HQs for the combined resident adult/child and commercial/industrial worker exposed to trichloroethene and radon in indoor air (vapor intrusion scenarios) were less than, respectively, $1x10^{-4}$ and 1.

Contaminants of Concern (COCs)

The site-related COPCs with baseline cumulative ELCRs greater than $1x10^{-4}$ or noncancer HQs greater than 1 are termed contaminants of concern (COCs). The COPCs that exceeded risk thresholds in groundwater are arsenic, cobalt, cyanide, iron, manganese, Ra-228, radon and thallium.

With the exception of Ra-228 at FWF, the presence of other contaminants (arsenic, cobalt, cyanide, iron, manganese, radon, and thallium) at the property groupings that exceed regulatory levels (i.e., MCLs or GWQS) or regional risk screening levels in groundwater are attributable to other (e.g., historic fill) sources and/or regional background concentrations and therefore not site-related. Specifically:

Arsenic – there is no evidence that arsenic was used in the mantle making process, arsenic is a common contaminant in historic fill and is associated with coal, which was observed in the boring logs developed during the installation of the monitoring wells.

Cobalt – there is no evidence that cobalt was used in the mantle making process and cobalt is associated with coal, which was observed in the boring logs developed during the installation of the monitoring wells.

Cyanide – there is no evidence cyanide was used in mantle making and it was not detected above regulatory levels (MCLs or GWQS).

Iron – although present in monazite ore, iron is also naturally occurring and is in historic fill.

Thallium – there is no evidence of use in the mantle making process, thallium is a common contaminant in historic fill and is also associated with coal.

Radon – The concentrations of radon in groundwater on-Site are similar to surrounding side and upgradient wells. Radon is found in groundwater throughout New Jersey and the levels found at the Site are comparable or less than concentrations found in public water supply or private wells according to data in the New Jersey Drinking Water Institute's report prepared in 2009 that provided a recommendation for the regulation of radon in water.

Manganese – although used in the mantle manufacturing process, the presence of manganese in groundwater is regional and upgradient/cross-gradient concentrations are comparable or greater than concentrations found downgradient of the Site.

Ra-228 at FWF, however, is present in groundwater at concentrations greater than the cross-gradient monitoring wells, is significantly greater than the federal MCL, and has been discovered to be present in a limited extent on the FWF, which is the only property grouping where soil remediation has not been completed. Ra-228 is therefore the only Site-related COC identified at the FWF.

Summary of Human Health Risks

In summary, the HHRA concluded that exposure to groundwater at the FWF property grouping would result in exceedances of EPA's target threshold values due to the presence of elevated Ra-228 in groundwater. Based on the results of the HHRA, a remedial action is necessary to protect public health, welfare, and the environment from actual and threatened releases of hazardous substances.

A complete discussion of all risks from OU4 of the Site can be found in the HHRA which is contained in the administrative record file for OU4 of the Site.

REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) are media-specific goals for protecting human health and the environment. They serve as the basis for developing remedial action alternatives and specify what the clean-up action will accomplish. The process of identifying RAOs occurs after the identification of affected media and contaminant characteristics, evaluation of pathways of exposure, contaminant migration pathways and exposure limits to receptors.

The following RAO has been developed for OU4 groundwater:

- Prevent/control human exposure to Ra-228 contaminated groundwater that exceeds drinking water standards.

An interim remedy would ensure that there is no human exposure to the site-related contaminant in groundwater while the on-going source control remedy, in conjunction with the process of radioactive decay, is reducing the concentration of radiological contaminants in soil and groundwater.

Remediation Goals

The Preliminary Remediation Goal (PRG) for groundwater developed for the COC identified in this document aids in defining the extent of the contaminated media requiring remedial action. PRGs are generally chemical-specific remediation goals for each medium and/or exposure route that are established to protect human health and the environment. They can be derived from applicable or relevant and appropriate requirements (ARARs), risk-based levels (human health and ecological), and from comparison to background concentrations, where available.

The PRG for Ra-228, the COC for groundwater at the Site, is the health-based value of 5 pCi/L, which is the State and federal MCL for total radium in groundwater. The State and federal MCL for radium is based on the total of the two radium isotopes, Ra-226 and Ra-228.

Principal Threat Waste

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a Site wherever practicable (NCP Section 300.430(a)(1)(iii)(A)). The "principal threat" concept is applied to the characterization of "source materials" at a Superfund Site. A source material is material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to groundwater, surface water or air, or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material. Since OU4 addresses contaminated groundwater, no principal threat wastes are addressed in this Proposed Plan. The principal threat waste (radiologically impacted soil) is addressed as part of the on-going OU1 soil excavation and off-site disposal remedial action.

SUMMARY OF REMEDIAL ALTERNATIVES

CERCLA Section 121(b)(1), 42 U.S.C. § 9621(b)(1), mandates that remedial actions be protective of human health and the environment, be cost effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Section 121(b)(1) of CERCLA also establishes a preference for remedial actions which use, as a principal element, treatment to permanently and significantly reduce the toxicity, mobility, or volume of the hazardous substances, pollutants, and contaminants at a site.

CERCLA Section 121(d), 42 U.S.C. § 9621(d), further specifies that a remedial action must attain a level or standard of control of the hazardous substances, pollutants, and contaminants which at least attains ARARs under federal and state laws, unless a waiver can be justified pursuant to CERCLA Section 121(d)(4), 42 U.S.C. § 9621(d)(4).

Detailed descriptions of the remedial alternatives summarized in this Proposed Plan for addressing Site-wide groundwater contamination are provided in the OU4 FS Report, which is part of the Administrative Record.

Alternative 1: No Action

Capital Cost	$0
Total O&M Cost	$0
Present Value	$0
Time to Construct	Not Applicable
Timeframe to reach PRGs	Approx. 30 years

The No Action alternative is required by the NCP to be carried through the screening process. Under this alternative, no action would be taken to remediate the contaminated groundwater.

Although no active remediation would be performed under this alternative, natural radioactive decay of the Ra-228 would still occur, although the results of this decay would remain unmonitored. Radioactive decay is a natural process that includes the transformation of a radioactive element to its daughter products accompanied by a decrease in radioactivity over a defined period of time. The defined period of time is known as a half-life (i.e., the interval of time for radioactivity to decrease by one-half), which for Ra-228 is 5.75 years. Radioactive decay results from the radioactive material transforming from an unstable material to a more stable material through processes (e.g., emission of alpha or beta particles) that decrease its radioactivity.

The migration and environmental impact of Ra-228 in groundwater would be reduced over time as a result of natural radioactive decay at the Site. In addition, historic mantle manufacturing processes/disposal practices that created acidic conditions in the soil allowing Ra-228 to migrate into groundwater ceased when the FWF discontinued operations. The soil environment is no longer acidic and thus, the ability of Ra-228 to continue to migrate into and through groundwater is limited. Ra-228 will have limited mobility in groundwater based on its physical properties and site conditions.

It is anticipated that following the removal of radiologically impacted soil (i.e., the source material) as part of the OU1 remedial actions, the amount of time necessary for present concentrations of Ra-228 in groundwater to radioactively decay to below the PRG (based on its half-life of 5.75 years) would be approximately 30 years. However, under this alternative, there would be no ICs preventing groundwater use before the PRG is reached, and no monitoring to evaluate the progress of the radiological decay to assure the decay is occurring at the rate predicted. ICs aid in ensuring there is no exposure by potential receptor populations to contaminated groundwater while radioactive decay is occurring over time.

The No Action alternative provides a baseline for comparison with the other remedial alternatives. Because no remedial activities would be implemented under the No Action alternative, long-term human health and environmental risks would remain the same as those identified in the HHRA, except for any changes due to radioactive decay over time, which would not be monitored. There are no capital, operations/maintenance or monitoring costs and no permitting or institutional legal restrictions needed. Under this alternative, conditions are expected to eventually meet the PRG established for groundwater, however, there would be no monitoring to ensure this and no restrictions on the use of the aquifer prior to restoration.

Alternative 2: Radioactive Decay with Institutional Controls and Long-Term Monitoring

Total Capital Cost	$275,000
Total Annual O&M Cost	$712,500
Total Present Value	$460,000
Time to Construct	1 year
Timeframe to reach PRGs	Approx. 30 years

Alternative 2 includes natural radioactive decay as defined and described under Alternative 1, which will result in the eventual achievement of the PRG for Radium-228.

ICs, such as a Classification Exception Area/Well Restriction Area (CEAs/WRA), would restrict groundwater uses or activities which could result in direct contact with contaminated groundwater. The CEA/WRA is an institutional groundwater use control established by the State of New Jersey under New Jersey legal authority. A WRA is established as a component of the implementation of the CEA. Under the WRA, a well permit not related to the response action (i.e., drinking water well) would not be approved by the State of New Jersey if the location of the well is within the CEA/WRA boundary unless the well meets the well restriction requirements stipulated in the CEA.

Due to the contaminated groundwater, a NJDEP CEA/WRA would be placed on OU4 to restrict future groundwater use activities that would expose users to Ra-228 at levels that may pose a human health risk until the PRG is met. A pre-design investigation would be conducted to further refine the extent of the Ra-228 groundwater contamination requiring the CEA/WRA.

The establishment/implementation of a groundwater LTM program would also be used to evaluate groundwater contamination over time as radioactive decay results in decreasing levels of Ra-228. The CEA would remain in place until the PRG is met through radioactive decay; however, the areal extent of the CEA would be reduced as the extent of groundwater impacts is reduced through radioactive decay. The WRA could be removed once PRGs have been achieved. Concurrent with the implementation of this Alternative, EPA would continue to implement the remaining OU1 soil excavation and off-site disposal at the FWF property grouping. Based on this work and groundwater data collected through LTM, EPA would monitor the progress of groundwater cleanup over time, and this will lead to the eventual selection of a final remedy for groundwater.

The timeframe for construction (i.e., construction of any new monitoring wells for the LTM program and development/implementation of the CEA/WRA) is approximately one year. With regard to a groundwater restoration timeframe, it is anticipated that once OU1 source removal activities are complete, the PRG would be met in approximately 30 years through radioactive decay. However, the achievement of the PRG will be carefully monitored by EPA and further refined in a final remedy when additional data is collected through LTM.

Removal of the source (radiologically impacted soil) that is contributing to groundwater contamination will be completed in approximately ten years. When source removal is complete, radioactive decay would be the primary driver for removal of Ra-228 from the groundwater. A CERCLA Five-Year Review Report would be prepared every five years to document groundwater conditions, Site status, report land use changes, and verify that the remedy continues to adequately protect human health and the environment at the Site.

Alternative 3: Groundwater Extraction & Treatment, Institutional Controls, and Long-Term Monitoring

Capital Cost	$6,175,000
Total O&M Cost	$22,993,750
Total Present Value	$12,540,000
Time to Construct	2-3 years
Timeframe to reach PRG	Approx. 30 years

Alternative 3 consists of groundwater extraction and ex-situ treatment (GWET) via co-precipitation of barium sulfate. Under this alternative, groundwater extraction activities would be conducted within the extent of the Ra-228 groundwater plume to address groundwater containing Ra-228 at concentrations greater than the PRG. Prior to construction activities, an investigation during the design phase of the project would be completed to further define the extent of Ra-228 in groundwater and to gather necessary design criteria to construct the treatment system.

It is conceptualized that three groundwater extraction wells would be installed in the vicinity of the groundwater plume on the FWF property grouping. The extraction wells would be screened within the deep aquifer to target extraction of Ra-228 contaminated groundwater. The estimated groundwater extraction rate would be in the range of 150 to 350 gallons per minute (gpm) per well for a total system flow rate of 450 to 1,050 gpm. The estimated flow rates are necessary to achieve capture over the extent of the groundwater contamination. The estimated flow rates are a function of the local hydrogeology and the proximity of the groundwater to the Delaware River.

Extracted groundwater would be routed through buried conveyance piping to a treatment system at a location to be determined during the design phase. Ra-228 in extracted groundwater would be removed through treatment by addition of barium chloride which removes Ra-228 from the groundwater by forming barium sulfate. Formation of the barium sulfate is very rapid (i.e., seconds to minutes) with formation of a relatively dense granular material that will tend to rapidly settle from suspension. This is followed by filtration. The partitioning of radium into this mineral form is very high and will likely allow compliance with the regulatory standard for either discharge to surface water or discharge to a publicly owned treatment works of the treated groundwater.

The ex-situ treatment system would also need to include treatment for non-Site related contaminants that were identified in groundwater during the RI (i.e., organic compounds and metals) to meet discharge requirements. Air stripping and/or activated carbon filtration are conventional technologies for treatment of organic compounds in groundwater. Precipitation/oxidation technologies provide effective removal of metals in groundwater.

Additional investigation activities conducted during the design phase of the project would be necessary to fully define the extent of the groundwater impacts, to determine influent flow rates to the treatment facility, to quantify expected influent concentrations, to select appropriate treatment equipment, and determine the most appropriate discharge location for treated groundwater.

Additionally, ICs and LTM would be established as described under Alternative 2. The ICs would place restrictions on future groundwater use while establishment of a groundwater monitoring program would assess the continued protectiveness of the remedy.

Since Ra-228 adheres well to soil and does not readily partition into groundwater, a groundwater treatment system would remove dissolved Ra-228, but Ra-228 in soil would continue to act as a source to groundwater. The GWET would not fully address Ra-228 reduction until all source material is removed under the ongoing OU1 cleanup. The GWET, ICs, and LTM would result in a restoration timeframe similar to Alternative 2 (i.e., approximately 30 years).

A CERCLA Five-Year Review Report would be prepared every five years until the PRG is met to document Site status, report land use changes, and verify that the remedy continues to adequately protect human health and the environment at the Site.

Comparative Analysis of Alternatives

Nine criteria are used to evaluate the different remedial alternatives individually and against each other to select a remedy. This section of the Proposed Plan profiles the relative performance of each alternative against the nine criteria, noting how it compares to the other options under consideration. The nine evaluation criteria are discussed below.

In keeping with EPA guidance, Alternatives 2 and 3 would be interim remedies that would protect human health and the environment in the short term and are intended to provide adequate protection in relation to the limited scope and goals of the remedial action, until a final remedy for the Site is implemented, upon completion of OU1 activities and after gathering additional groundwater data to support a final remedy.

Threshold Criteria

Overall Protection of Human Health and the Environment

After the removal of source material at the FWF, based on the current maximum concentrations identified at the FWF, under Alternative 1, No Action, natural processes result in the restoration of groundwater in an estimated 30 years.

However, Alternative 1 would provide neither any means of environmental monitoring to assess the progress of groundwater restoration, nor any ICs to prevent groundwater use or exposure to contaminants until the PRG is achieved.

Without ICs (e.g., CEA/WRA), the alternative would not meet the RAO of preventing human exposure to Ra-228, offering no protection against possible future use of groundwater at the Site for the duration of radioactive decay (an estimated 30 years) to reach PRGs. Therefore, Alternative 1 does not meet this threshold criterion.

Alternative 2 would not include active treatment but contaminant concentrations would be reduced through radioactive decay. This alternative satisfies this criterion by incorporating ICs and monitoring groundwater contaminant levels at the Site. ICs would restrict the use of groundwater subject to the requirements of the CEA/WRA. ICs would be protective since they would address potential exposure to impacted groundwater by restricting the exposure pathway. Implementation of LTM would allow EPA to evaluate the levels of groundwater contamination over time, ensuring the use of ICs are protective of human health and the environment.

Alternative 3 would provide protection of human health and the environment by improving groundwater quality through extraction and treatment of impacted groundwater and through natural radioactive decay. Similar to Alternative 2, ICs and monitoring would be implemented.

While not a final action for the Site, Alternatives 2 and 3 are expected to be protective of human health and the environment in the short term, until additional data is collected to support a final groundwater remedy.

Compliance with ARARs

The primary chemical-specific ARAR is the federal MCL for total radium in groundwater, which is 5 pCi/L. Although there is no action associated with Alternative 1, the chemical-specific ARAR for Ra-228 is expected to be met via radioactive decay over time. However, without monitoring, EPA would not be able to confirm compliance with this ARAR, and without ICs, including the action specific requirement for a CEA/WRA, the alternative would offer no protection against possible future use of groundwater at the Site for the duration of radioactive decay until the PRG is reached.

Alternative 2 would comply with chemical-specific ARARs by meeting the PRG through radioactive decay as well as action-specific ARARs through the implementation of the ICs. Alternative 3 would comply with the chemical-specific ARARs by remediating Ra-228 in groundwater via GWET in conjunction with radioactive decay. Alternative 3 would be designed to comply with action-specific and location-specific ARARs regarding discharge to surface water, including those applicable to non-Site related contaminants that were identified in groundwater during the RI (i.e., organic compounds and metals), disposal of waste generated from the treatment operations, and preservation of historical resources potentially located at the site.

EVALUATION CRITERIA FOR SUPERFUND REMEDIAL ALTERNATIVES

1. Overall Protection of Human Health and the Environment evaluates whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.

2. Compliance with ARARs evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified.

3. Long-term Effectiveness and Permanence considers the ability of an alternative to maintain protection of human health and the environment over time.

4. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contaminant present.

5. Short-term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, the community, and the environment during implementation.

6. ***Implementability*** considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.

7. ***Cost*** includes estimated capital and annual operation and maintenance costs, as well as present-worth cost. Present-worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

8. ***State Acceptance*** considers whether the State agrees with EPA's analyses and recommendations, as described in the RI/FS and Proposed Plan.

9. ***Community Acceptance*** considers whether the local community agrees with EPA's analyses and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

<u>Balancing Criteria</u>

Long-term Effectiveness and Permanence

This criterion takes into account the residual risk remaining at the conclusion of remedial activities, and the adequacy and reliability of containment systems and ICs. Interim remedies are intended to be protective of human health and the environment in the short term, and to provide adequate protection until the final remedy is implemented. This interim approximately 10-year period needed for EPA to complete the OU1 source removal remedial action, and an additional period of 30 years after which EPA expects conditions to meet the PRGs. Long-term protectiveness and permanence will be documented in a final remedy selection process for groundwater.

Both Alternative 2 and Alternative 3 would achieve the RAO in the same timeframe with the implementation of ICs.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Radioactive decay, not treatment serves as the primary mechanism for the reduction of toxicity, mobility, and volume of contamination in groundwater for Alternative 2. Additionally, ICs would be in place to protect potential human receptors through pathway elimination, and LTM would monitor contaminant concentration trends over time to assess the effectiveness and progress of radioactive decay in restoring groundwater.

Alternative 3 includes active removal of contamination in conjunction with radioactive decay which would result in reduction of toxicity, mobility, and volume of contaminant mass through treatment. Groundwater monitoring would assess remediation effectiveness and ICs would protect potential human receptors throughout remedy implementation. The GWET plant would be designed to treat non-Site-related contaminants in addition to Ra-228, including metals and organic compounds.

Short-Term Effectiveness

Short-term effectiveness considerations associated with Alternative 2 include the time needed to perform monitoring well installation and LTM of groundwater through new and existing wells. Implementation time for this work and the development of the ICs is estimated to be approximately one year. Risks to human health and environment would be minimal during these activities as potential health and safety considerations would be addressed by the development and implementation of a Health and Safety Plan.

Construction activities associated with Alternative 3 would present a greater potential for short-term impacts, including a much greater implementation time than Alternative 2. This is due to the construction work (construction of a GWET facility) largely occurring at an active port facility that operates 24 hours per day, 7 days a week. The continuous operation of the port facility creates a large volume of tractor trailer and other vehicular traffic that could pose significant safety concerns to both port facility workers and construction personnel. There is a seasonality to operation of the port facility that constrains when field work could be performed. Given the active nature of the port facility and the seasonality of the operation, the implementation time would be much longer than for Alternative 2.

Risks associated with on-site construction activities for Alternatives 2 and 3 would be minimized with the use of administrative (i.e., Health and Safety Plan, traffic control plan, storm water pollution prevention plans, etc.) and engineering controls (i.e., sheeting/shoring for utility trenching, traffic control devices, etc.).

Implementability

Groundwater monitoring and ICs associated with Alternatives 2 and 3 would be readily implementable. The construction of the GWET facility for Alternative 3, while implementable from a treatment technology perspective, would present significant construction/logistical challenges given the current use and history of the FWF. These challenges would include:

- Logistics associated with conducting drilling, utility trenching, and treatment building construction activities at a port facility that operates 24-hours a day, 7 days a week.
- Health and safety risks to port facility workers and construction personnel associated with conducting construction work in the port environment, including the constant flow of tractor trailer and other vehicular traffic 24 hours per day, 7 days per week, amidst the presence of open excavations, and overhead hazards.
- The lack of easily available space to construct a GWET facility on the property.

- The presence of historic fill, building foundations, and potential archeological resources that would greatly complicate the installation of utility trenches connecting the extraction wells to the treatment facility, as well as the effluent discharge piping from the facility.

Monitoring and sampling activities have previously occurred at the FWF. ICs would require some coordination with NJDEP and the property owner, but technical implementation of monitoring and sampling activities is expected to be relatively straightforward.

Cost

A comparative summary of the cost estimates for each alternative is presented below:

Alternative	Capital Cost	Total O&M Cost	Total Present Value (7% Discount Rate)
1	$0	$0	$0
2	$275,000	$588,000	$460,000
3	$6,175,000	$22,994,000	$12,540,000

Modifying Criteria

State Acceptance

The State of New Jersey supports EPA's preferred alternative as presented in this Proposed Plan.

Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends and all comments are reviewed. Comments received during the public comment period will be addressed in the Responsiveness Summary section of the ROD. The ROD will document EPA's selected remedy for OU4 at the Site.

PREFERRED ALTERNATIVE

Based upon the evaluation of the remedial alternatives, EPA proposes Alternative 2, Radioactive Decay with Institutional Controls and Long-term Monitoring as the preferred remedial alternative for OU4 of the Welsbach/GGM Site.

The preferred alternative for OU4 will be an interim remedy rather than a final Site-wide remedy for groundwater. A final groundwater remedy will be selected, with input from the public, when additional groundwater data have been collected during implementation of the interim remedy, as well as additional data related to the ongoing OU1 remediation action which addresses the remaining source material (i.e., radiologically impacted soil).

The major components of the preferred alternative are as follows:

- Radioactive decay of Radium-228 in groundwater;
- Implementation of ICs (CEA/WRA) to restrict potential contact with contaminated groundwater; and,
- LTM program for groundwater to ensure the effectiveness of the ICs and assess the progress of the on-going OU1 soil excavation and off-site disposal in conjunction with radioactive decay.

The ICs, in the form of a CEA/WRA, will restrict future groundwater use activities that would expose users to Ra-228 at levels that may pose a human health risk while the OU1 soil excavation and off-site disposal is on-going in conjunction with radioactive decay of Ra-228. The CEA/WRA would be established to ensure that the remedy remains protective until the interim remedy RAO has been achieved, as well as any additional RAO(s) that may be identified as part of a final groundwater remedy for protection of human health over the long term.

A pre-design investigation would be conducted to further refine the extent of the Ra-228 groundwater contamination requiring the CEA/WRA. The number of existing wells sampled and/or new monitoring wells installed as part of the pre-design investigation will be specified in a Pre-Design Investigation Work Plan.

The establishment/implementation of a groundwater LTM program would also be used as a basis for evaluating the CEA/WRA and assessing groundwater conditions over time. Details of the LTM program would be developed during the remedial design phase and implemented to track and monitor changes in the groundwater contamination to ensure the RAO and the PRG are attained through radioactive decay.

The environmental benefits of the preferred alternative would be enhanced by giving consideration, during the remedial design, to technologies and practices that are sustainable in accordance with EPA Region 2's Clean and Green Policy. This would include green remediation technologies and practices.

The total estimated present worth cost for the preferred alternative is $460,000. Further details regarding the cost are presented in the OU4 FS Report. This is an engineering cost estimate that is expected to be within the range of plus 50 percent to minus 30 percent of the actual project cost.

While this alternative would ultimately result in a reduction of contaminant levels in groundwater, it would take longer than five years to achieve these levels. As a result, in accordance with CERCLA, the OU4 remedy will be reviewed at least once every five years until remediation goals are achieved, which is estimated to take 30 years following implementation of the soil remedy. In addition, a final remedy for groundwater will be selected in a subsequent ROD based on data to be collected during the interim remedy, as well as data collected during the ongoing implementation of the OU1 remedy.

BASIS FOR THE REMEDY PREFERENCE

Alternative 2, the preferred alternative, addresses groundwater contamination related to the Welsbach/General Gas Mantle Superfund Site. This interim action will prevent exposure to potential future use receptors at risk (adult/child residents and/or commercial/industrial workers) via the use of ICs and assess the process of radioactive decay in reducing the concentrations of Ra-228 in groundwater over time through a LTM program. This interim remedy will be implemented while the principal threat waste (radiologically impacted soil) is addressed as part of the on-going OU1 soil excavation and off-site disposal remedial action.

The proposed OU4 action will be an interim remedy rather than a final Site-wide groundwater remedy in order to provide short term protection to potential receptors of Site groundwater, while EPA addresses the remaining source material (i.e., radiologically impacted soil) through an ongoing remedial action for OU1. The RAO is designed to be a measurable and achievable objective for the prevention of exposure to impacted groundwater by potentially exposed receptor groups through the use of ICs.

Alternative 2 relies on natural radioactive decay, which will be effective in reducing the concentration of Ra-228 in groundwater to its PRG. Both ICs and LTM are effective components of the preferred alternative. ICs, in the form of a CEA/WRA will ensure that the remedy remains protective until the RAO and PRG are achieved. LTM will track and monitor changes in the groundwater contamination to ensure the RAO and PRG are attained through radioactive decay. LTM will also provide data that EPA will use to develop a final remedy for Site groundwater.

Based upon the information currently available, EPA believes the preferred alternative meets the threshold criteria *(protection of human health and the environmen*t and c*ompliance with ARARs*) and provides the best balance of tradeoffs among the other alternatives with respect to the balancing criteria. The preferred alternative satisfies the following statutory requirements of CERCLA: 1) the proposed remedy is protective of human health and the environment; 2) it complies with ARARs; 3) it is cost effective. and 4) it utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The preferred remedy relies on the principle of radioactive decay and is an interim remedy.

The ICs in the form of a CEA/WRA will restrict future groundwater use activities that would expose users to Ra-228 at levels that may pose a human health risk. The CEA/WRA would be established to ensure that the remedy remains protective until the RAO is achieved for protection of human health over the long term. Long-term monitoring would be performed to assure the protectiveness of the remedy and monitor the progress of radioactive decay.

With respect to the two modifying criteria of the comparative analysis (*state acceptance* and *community acceptance*), NJDEP has concurred on this Proposed Plan. Community acceptance of the preferred alternative will be evaluated after the public comment period ends and all comments are reviewed.

COMMUNITY PARTICIPATION

EPA and NJDEP provided information regarding the cleanup of the Welsbach/General Gas Mantle Superfund Site to the public through meetings, the administrative record file for the Site and announcements published in the *Courier Post*. EPA and NJDEP encourage the public to gain a more comprehensive understanding of the Site and the Superfund activities that have been conducted. The dates for the public comment period; the date, location, and time of the public meeting; and the locations of the administrative record file are provided on the front page of this Proposed Plan.

For further information on the Welsbach/GGM OU4 Superfund Site, please contact:

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Written comments on this Proposed Plan should be submitted on or before September 24, 2021, to Thomas Dobinson at the address below or email above.

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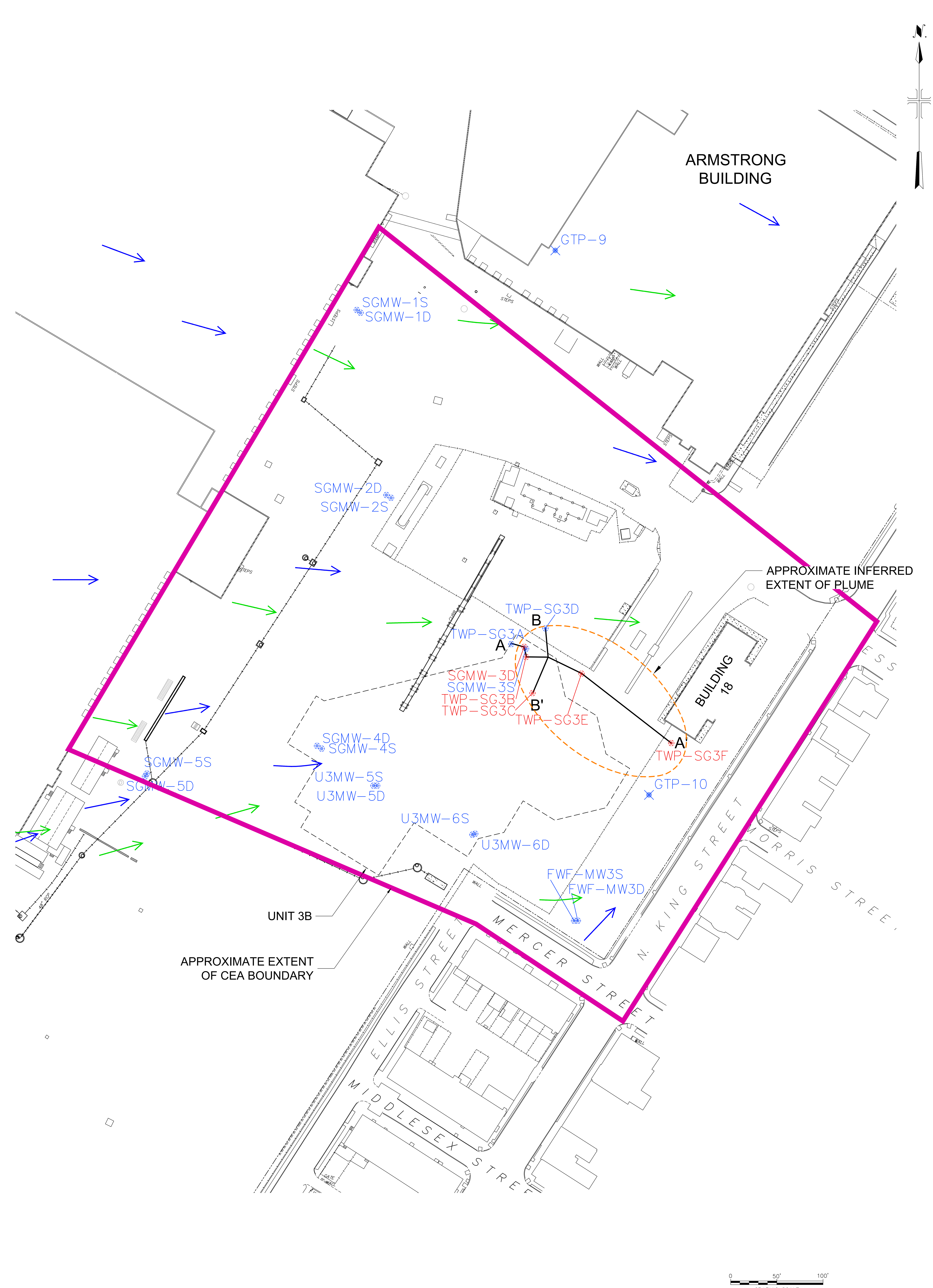

NOTE:

CEA = CLASSIFICATION EXCEPTION AREA

LEGEND

- ABOVE Ra MCL
- BELOW Ra MCL
- SHALLOW GROUNDWATER FLOW ARROWS
- DEEP GROUNDWATER FLOW ARROWS

FEASIBILITY STUDY REPORT
FOR OPERABLE UNIT 4
WELSBACH/GENERAL GAS MANTLE SUPERFUND SITE

ALTERNATIVE 2 - INSTITUTIONAL CONTROLS AND LONG TERM MONITORING

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

Table 1
Summary of Risks and Hazards for the RME Scenario by Property Grouping - All OU4 Monitoring Wells
Welsbach/General Gas Mantle Superfund Site
Camden and Gloucester City, New Jersey

Summary of Risks and Hazards for RME Scenario for All OU4 Wells										
	Exposure Area									
	FWF		SC		GGM		HS		JB-TA	
Receptor	ELCR	HI	ELCR	HI	ELCR	HI	ELCR	HI	ELCR	HI
Resident[2] - Potable and Household Use										
Chemical	6E-04	14	3E-04	12	2E-04	44	7E-04	22	2E-03	47
Radiological	3E-03	--	1E-02	--	1E-02	--	6E-03	--	3E-03	--
Receptor Total	**3E-03**	**14**	**1E-02**	**12**	**1E-02**	**44**	**7E-03**	**22**	**5E-03**	**47**
Resident[2] - Vapor Intrusion										
Chemical	9E-07	0.2	NA	NA	NA	NA	NA	NA	NA	NA
Receptor Total	9E-07	0.2	--	--	--	--	--	--	--	--
Commercial/Industrial Worker - Potable and Sanitary Use										
Chemical	1E-04	2	6E-05	2	5E-05	3	2E-04	3	5E-04	5
Radiological	4E-05	--	7E-05	--	8E-05	--	7E-05	--	4E-05	--
Receptor Total	**2E-04**	**2**	1E-04	**2**	1E-04	**3**	**2E-04**	**3**	**5E-04**	**5**
Commercial/Industrial Worker - Potable and Process Use										
Chemical	2E-04	3	6E-05	2	5E-05	10	2E-04	4	5E-04	9
Radiological	7E-04	--	3E-03	--	3E-03	--	2E-03	--	9E-04	--
Receptor Total	**9E-04**	**3**	**3E-03**	**2**	**3E-03**	**10**	**2E-03**	**4**	**1E-03**	**9**
Construction Worker - Excavation Scenario										
Chemical	NA	NA	2E-08	0.1	3E-09	0.3	NA	NA	9E-09	0.08
Radiological	NA	NA	5E-05	--	3E-05	--	NA	NA	3E-06	--
Receptor Total	--	--	5E-05	0.1	3E-05	0.3	--	--	3E-06	0.08
Commercial/Industrial Worker - Vapor Intrusion										
Chemical	4E-08	0.01	NA	NA	NA	NA	NA	NA	NA	NA
Receptor Total	4E-08	0.01	--	--	--	--	--	--	--	--

Notes:
1. **Bold** receptor totals exceed the risk range established by the National Contingency Plan (i.e., 1E-04) or a target hazard index of 1.
2. For the resident, non-cancer hazard quotients are computed based on an exposure duration of 6 years as a child. For the RME scenario, a combined adult/child cancer risk (rather than a strictly adult cancer risk) is computed as 6 years at the child's rate of exposure and 20 years at the adult's rate of exposure (USEPA 2014c).

ELCR = excess lifetime cancer risk
FWF = Former Welsbach Facility
GGM = General Gas Mantle property
HI = hazard index
HS = Hunter Street
JB-TA = Johnson Boulevard and Temple Avenue
NA = not applicable
RME = reasonable maximum exposure
SC = Swim Club